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(54) SELF-ORIENTING FRACTURING SLEEVE AND SYSTEM

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(51) **Int. Cl.**
E21B 43/26 (2006.01)
E21B 17/10 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 43/26*** (2013.01); ***E21B 17/1057*** (2013.01); ***E21B 17/1078*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 43/26; E21B 17/1057; E21B 17/10778
USPC 166/308.1, 378, 177.5, 242.6
See application file for complete search history.

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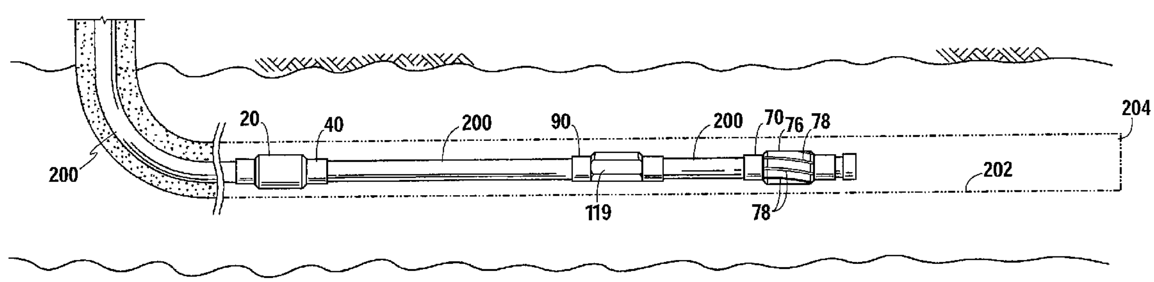
Primary Examiner — Elizabeth Gitlin

(57) **ABSTRACT**

A self-orientating fracturing system including a swivel sub having opposing sections rotatable relative to one another; at least one ported sleeve defining a flowpath and having a ported housing with an outer surface that includes at least one planar engagement surface and at least one port providing a communication path to the interior of said housing, and an insert moveable within the ported housing between a first position and a second position, for opening and closing the ported sleeve. The system includes a centralizer having an outer surface configured to impart rotational force to the centralizer when the centralizer is pushed or culled alone the surface of a wellbore. The sorted sleeve and the centralizer are installed in the assembly on the same side of the swivel sub such that the rotational force imparted to the centralizer is also imparted to the swivel sub.

16 Claims, 5 Drawing Sheets



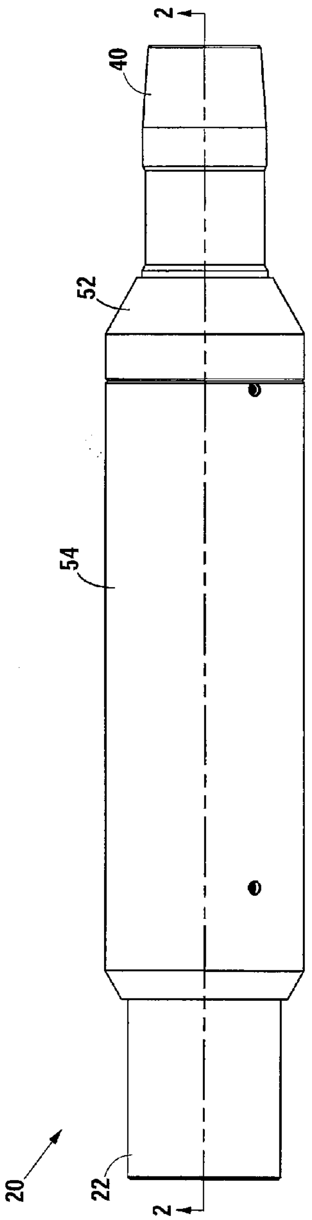

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Fig. 1

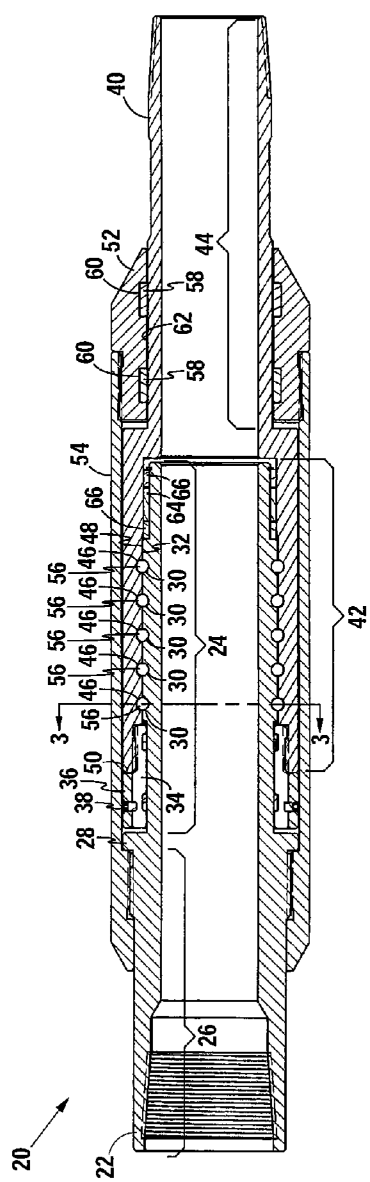
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Fig. 2

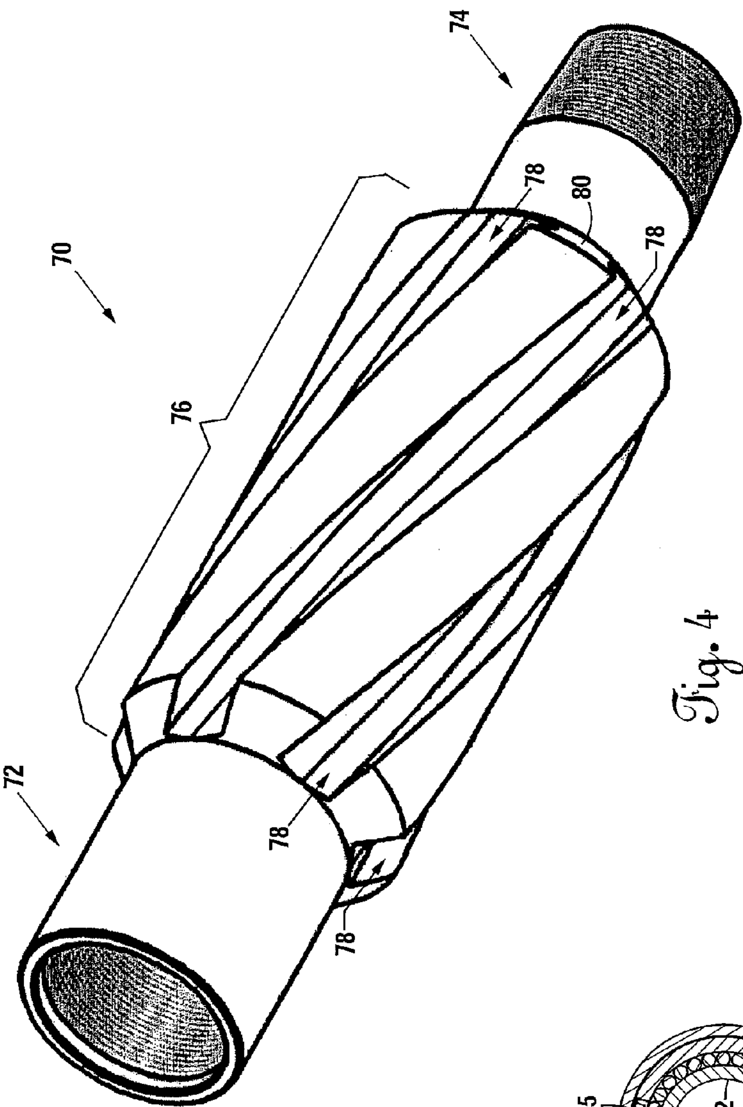

Fig. 4

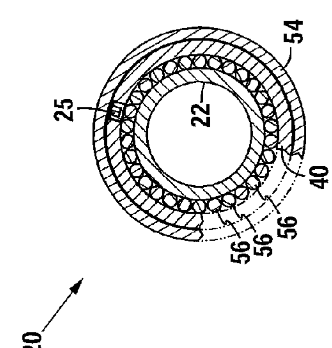

Fig. 3

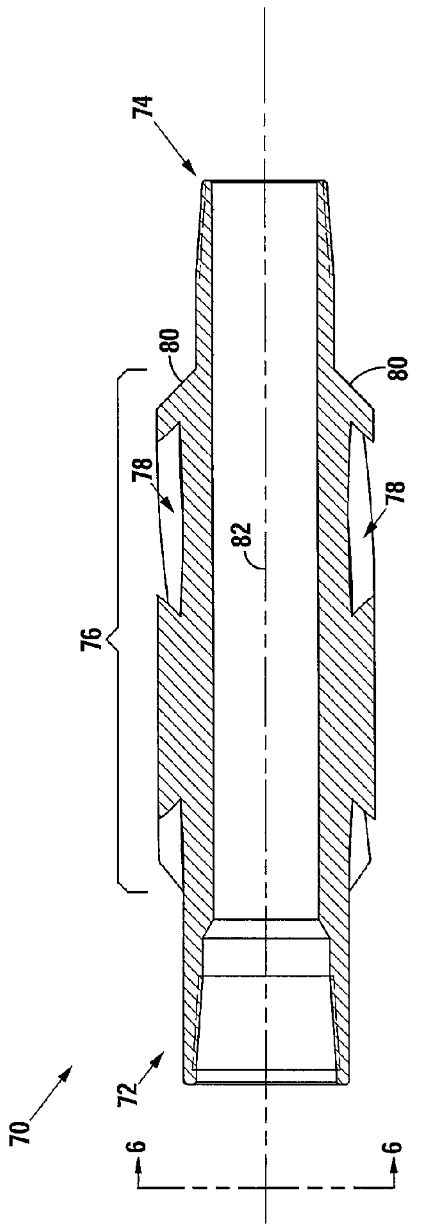

Fig. 5

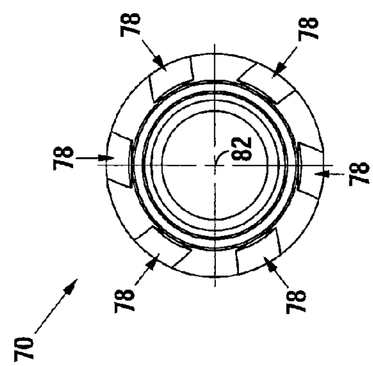

Fig. 6

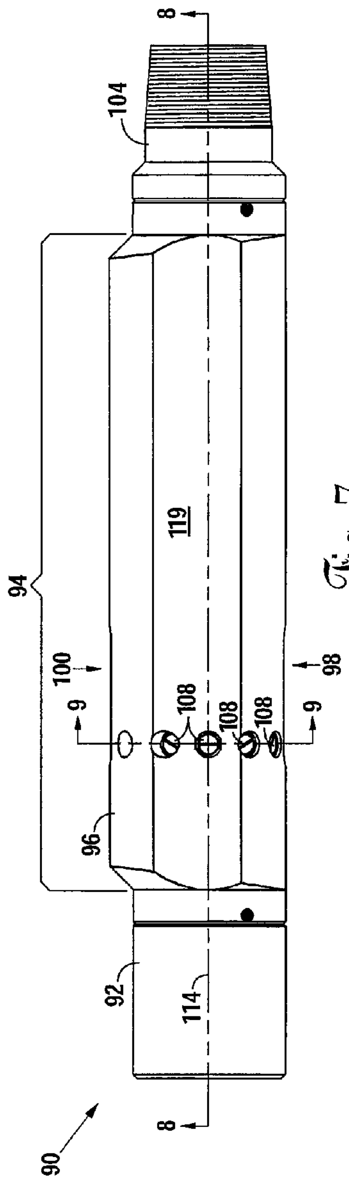

Fig. 7

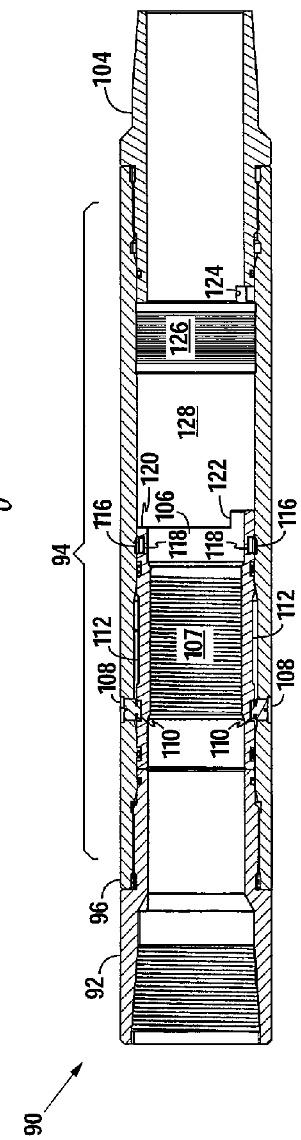

Fig. 8

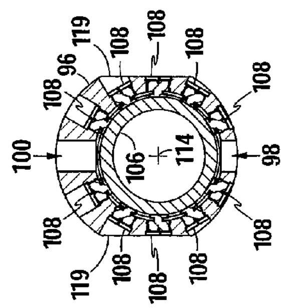

Fig. 9

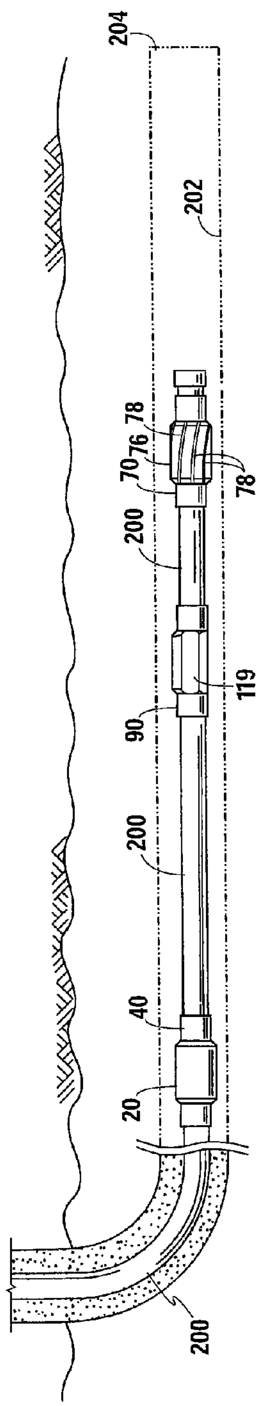
204
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Fig. 10

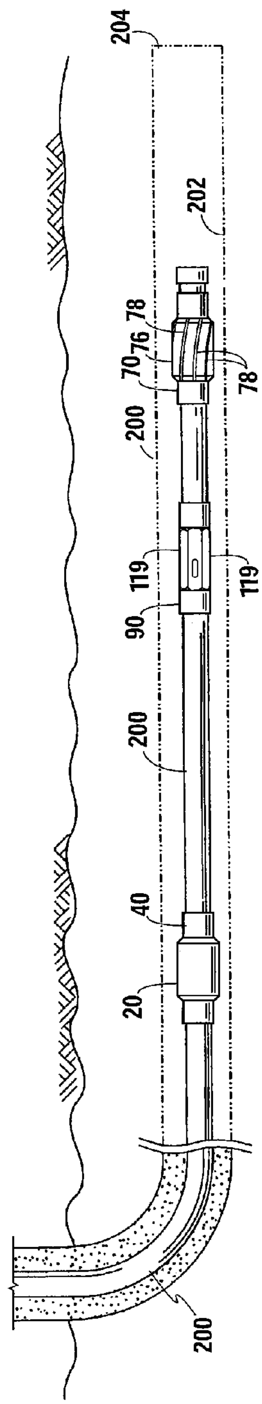
204
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Fig. 11

SELF-ORIENTING FRACTURING SLEEVE AND SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

This original non-provisional application claims benefit of and priority to U.S. Provisional Application Ser. No. 61/381,376, filed Sep. 9, 2010 and entitled "Self-Orienting Fracturing Sleeve and System," which is incorporated by reference herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to oil and natural gas production. More specifically, the invention is a system and method for fracturing within a limited range or within a specifically-desired direction within a hydrocarbon production zone.

2. Description of the Related Art

In hydrocarbon wells, fracturing (or "fracing") is a technique used by well operators to create and extend fractures from the wellbore into the surrounding formation, thus increasing the surface area for formation fluids to flow into the well. Fracing is typically accomplished by either injecting fluids into the formation at high pressure (hydraulic fracturing) or injecting fluids laced with round granular material (proppant fracturing) into the formation. In either case, the fluids are pumped into the tubing string and into the formation through ports disposed in downhole tools, such as fracing valves.

Some productions zones present particular difficulties due to their thinness. For example, a particular zone may be only ten, fifty or one-hundred feet thick, presenting only a thin layer of formation in which to drill a lateral wellbore. Moreover, fracing vertically past (i.e., either above or below) the production zone can allow the introduction of production impediments into the production zone, such as if, for example, a volume of water is positioned above and within the fracing range of the tool. Fracing past the production zone vertically downward presents the possibility of providing an egress path out of the production zone.

BRIEF SUMMARY OF THE INVENTION

The present invention addresses these and other problems associated with the fracing in relatively thin production zones. The system comprises a swivel sub having a connection radially rotatable relative to the tubing string portion located upwell; at least one ported sleeve positionable downwell of said swivel sub, said at least one ported sleeve defining a flowpath and comprising a ported housing having an outer surface with at least one planar engagement surface and at least one port providing a communication path to the interior of said housing; and an insert moveable within said ported housing between a first position and a second position, wherein in said first position said insert is positioned radially between said at least one port and said flowpath. The system further comprises a centralizer having a outer surface with at least one flute formed therein, said centralizer positionable downwell of said swivel sub.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a side elevation of a preferred embodiment of the swivel sub of the present invention.

FIG. **2** is a sectional of the swivel sub of FIG. **1** through section line **2-2** of FIG. **1**.

FIG. **3** is a sectional elevation of the swivel sub of FIG. **1** through section line **3-3** of FIG. **2**.

FIG. **4** is a perspective view of a preferred embodiment of the centralizer of the present invention.

FIG. **5** is a side sectional view of the centralizer of FIG. **5** through the longitudinal center plane.

FIG. **6** is a front elevation of the centralizer.

FIG. **7** is a side elevation of the low-side ported sleeve of the present invention.

FIG. **8** is a sectional elevation through section line **8-8** of FIG. **7**.

FIG. **9** is a sectional view through section line **9-9** of FIG. **7**.

FIG. **10** shows the preferred embodiment described with reference to FIGS. **1-9** in use with a well.

FIG. **11** shows the embodiment of FIG. **10** with the ported sleeve rotated.

DETAILED DESCRIPTION OF THE INVENTION

When used with reference to the figures, unless otherwise specified, the terms "upwell," "above," "top," "upper," "downwell," "below," "bottom," "lower," and like terms are used relative to the direction of normal production through the tool and wellbore. Thus, normal production of hydrocarbons results in migration through the wellbore and production string from the downwell to upwell direction without regard to whether the tubing string is disposed in a vertical wellbore, a horizontal wellbore, or some combination of both. Similarly, during the fracing process, fracing fluids move from the surface in the downwell direction to the portion of the tubing string within the formation.

FIGS. **1-3** show a swivel sub **20** of the preferred embodiment of the system. The swivel sub **20** comprises a top connection **22** having a lower portion **24** and an upper portion **26** separated by a middle shoulder **28**. A plurality of bearing grooves **30** are formed in the outer surface **32** of the lower portion **24**. A split ring **34** is positioned downwell of and adjacent to the middle shoulder **28**. A split ring retainer **36** is fastened to the split ring **34** with a plurality of grub screws **38** radially aligned therearound.

A lower connection **40** comprises an upper portion **42** and a lower portion **44**. The upper portion **42** partially encompasses the lower portion **24** of the top connection **22** and has a plurality of bearing grooves **46** formed in the inner surface **48** thereof. An annular upper end **50** of the lower connection **40** is adjacent to the lower end of the split ring retainer **36**. The lower portion **44** extends through a housing sub **52**. A housing **54** is positioned around a portion of the top connection **22** and an upper portion of the housing sub **52**. Annular bearings **58** are positioned in bearing grooves **60** formed in the interior surface **62** of the housing sub **52**.

The interiors of the top connection **22** and lower connection **40** form a longitudinal flowpath through the swivel sub

20. The flowpath is substantially sealed from the surrounding formation by annular seal stack **64** bounded by annular seal spacers **66**.

A plurality of balls **56** is positioned in the annular bearing channels formed by placement of the lower connection **40** around the top connection **22**, with bearing grooves **30**, **46** aligned. As shown in FIG. **3**, access to the channels is through a passage blocked by a grub screw **25**. Although FIG. **3** shows a single channel filled with balls **56**, each of the other four channels shown in FIG. **2** is identically shaped and contains a plurality of balls **56**. Distributing torque across multiple channels housing multiple balls helps minimize any destructive effects of longitudinal torque.

FIGS. **4-6** show the preferred centralizer **70** of the system. The centralizer **70** has an upper end **72** and a lower end **74** for attachment to the other elements of a tubing string. A middle section **76** of the centralizer **70** has an enlarged outer diameter relative to the upper and lower ends **72**, **74**. Six flutes **78** are formed in the middle section **76** of the centralizer **70** spiraling around the exterior surface at six degrees per inch of rotation, and angled at thirty degrees from normal. An annular front surface **80** of the middle section **76** is angled at forty-five degrees relative to the longitudinal axis **82**.

FIG. **7-9** show the low-side ported sleeve **90** of the system. The ported sleeve **90** comprises a top connection **92** threadedly engaged with a ported housing **96** having opposing first and second flow ports **98**, **100**. The lower end of the ported housing **96** is threadedly engaged with the bottom connection **104**. An insert **106** having an engagable inside surface **107** is movable between a first position, shown in FIG. **8**, and a second position (not shown) that is downwell from the first position.

In the first position, the insert **106** is positioned between the ports **98**, **100** to at least substantially prevent fluid flow between the flowpath and the exterior of the ported sleeve **90**. Shear screws **108** are positioned through the ported housing **96** and engaged with the insert **106** in a groove **110** formed in the exterior surface **112** of the insert **106**.

A middle section **94** of the ported housing **96** has an asymmetrical profile around the longitudinal axis **114** of the flowpath. A ratchet ring **116** is positioned in a ratchet ring groove **118** proximate to the lower end **120** of the insert **106**. The exterior surface of the middle portion **94** has opposing engagement surfaces **119**.

To shift the insert **106**, a shifting device (not shown) is inserted through the string and engages the inside surface **107** of the insert **106**. The shifting device is caused to exert force in the downwell direction sufficient to fracture the shear screws **108** and allow the insert **106** to be moved downwell to the second position, in which locking surface **122** of the insert engages with a locking surface **124** in upper end the bottom connection **104** to prevent rotation of the insert **106**. In this position, the ratchet ring **116** engages a ratchet section **126** formed in the inner surface **128** of the ported housing **96**.

As shown in FIG. **10**, during use, the centralizer **70** and low-side sleeve **90** are positioned in a tubing string **200** downwell from the swivel sub **20**, and are therefore freely rotatable relative to the portion of the tubing string upwell of the swivel sub **20**. Thus, the engagement surfaces **119** initially may be radially orientated in any direction (e.g., parallel to the low side, or bottom surface, of the wellbore; vertical relative to the low side of the wellbore, or any rotational position in between) relative to the low side of the wellbore. Similarly, because they are positioned radially between the engagement surfaces **119**, the ports **98**, **100** may also be initially radially positioned in any direction, including orientated to direct fracing fluid vertically.

As the tubing string **200** is tools are run into the lateral portion of the wellbore, gravity causes the tubing string **200**, centralizer **70**, and ported sleeve **90** to contact the low side **202** (i.e., bottom) of the wellbore **204**. When the centralizer **70** engages with the ground surface, fluted middle section **76** engages the low side of the wellbore and urges rotation of the centralizer **70** and attached tubing, including the ported sleeve **90**, in the direction of flutes **78**. The swivel sub **20** allows such rotation due to the rotatability of the lower connection **40** relative to the top connection **22**, as described with reference to FIGS. **1-3**.

If an engagement surface **119** is not already positioned against the low side **202** of the wellbore **204**, rotation of the ported sleeve **90** will continue until such positioning occurs—that is, the ported sleeve **90** will be rotated along with the centralizer **70** until one of the engagement surfaces **119** substantially contacts the low side of the lateral wellbore **204**. The eccentric shaping of the middle section **94** facilitates rotation by causing the center of mass to be misaligned with the flowpath's longitudinal axis.

When an engagement surface **119** of the low-side sleeve **90** contacts the low side **202** of the wellbore **204**, frictional engagement of the engagement surface **119** is sufficient to resist the rotational urging caused by the fluted centralizer **70**, after which the sleeve **90** and centralizer **70** drag straight within the wellbore as the tubing string **200** is moved further into the lateral **204**. In this orientation, which is shown in FIG. **11**, because they are positioned between the engagement surfaces **119**, the opposing ports **98**, **100** are then oriented to direct flow horizontally, rather than vertically, through the relatively thin production zone. Frictional contact of the engagement surface **119**, along with the weight of the tubing string helps resists further rotational urging.

Because of the eccentricity, the low-side sleeve **90** may be run with measuring devices on the outside to make it effectively centric so that the eccentricity will not cause the tool to hang up in the well bore.

The present invention is described in terms of preferred embodiment in which a specific system and method are described. Those skilled in the art will recognize that alternative embodiments of such system, and alternative applications of the method, can be used in carrying out the present invention. Other aspects and advantages of the present invention may be obtained from a study of this disclosure and the drawings, along with the appended claims. Moreover, the recited order of the steps of the method described herein is not meant to limit the order in which those steps may be performed.

We claim:

1. A self-orientating fracing system for use in an open hole, the system comprising:

a swivel sub having:

a lower connection radially rotatable relative to a portion of a tubing string connected to the swivel sub, said portion of the tubing string located upwell of the swivel sub;

a top connection having a first upper portion and a first lower portion with an outer surface, said first lower portion having an outer diameter smaller than the outer diameter of the first upper portion, and at least one bearing groove formed in the outer surface of the first lower portion;

a lower connection having a second upper portion and a second lower portion with an inner surface, wherein the second upper portion of the lower connection encompasses at least part of said first lower portion of the top connection, and at least one bearing groove formed in the inner surface of the second upper portion;

a housing assembly encircling at least a portion of said top connection and at least a portion of the lower connection;

at least one ported sleeve located downwell of said swivel sub, the at least one ported sleeve defining a flowpath; and

at least one centralizer having an outer surface comprising a plurality of flutes, the outer surface substantially radially symmetrical;

wherein,

the at least one centralizer is located downwell of said swivel sub;

the at least one bearing groove formed in the outer surface of the top connection is radially aligned with the at least one bearing groove formed in the inner surface of the lower connection forming at least one annular channel between the top connection and the lower connection;

at least one bearing is positioned in the at least one annular channel; and

said lower connection is radially rotatable relative to the top connection.

2. The self-orientating fracing system of claim **1** wherein said housing assembly having at least one bearing groove formed therein, and further comprising at least one annular bearing positioned in said at least one bearing groove of said housing assembly and radially between the lower connection and the housing assembly; and

wherein said lower connection is readily rotatable relative to the housing assembly.

3. The self-orientating fracing system of claim **1** wherein said housing assembly comprises:

a housing connected to a housing sub, said housing being attached to the top connection, said housing sub being attached to the housing and encircling at least a portion of second lower portion of the lower connection.

4. The self-orientating fracing system of claim **1** further comprising a middle shoulder formed in said top connection between said first upper portion and said first lower portion, wherein downwell movement of said housing assembly relative to said top connection is limited by contact of said housing assembly with said middle shoulder.

5. The self-orientating fracing system of claim **4** further comprising a split ring and split ring retainer positioned around the first lower portion of said top connection, said split ring and said split ring retainer being longitudinally positioned between an annular upper end of the lower connection and the middle shoulder of the top connection.

6. The self-orientating fracing system of claim **1** wherein said lower connection has at least one radial passage therethrough, the at least one radial passage being aligned with the at least one bearing groove formed in the inner surface of the second upper portion.

7. The self-orientating fracing system of claim **1** wherein said at least one ported sleeve comprises:

a ported housing having an interior and a middle section with an asymmetrical profile and an outer surface with at least one flattened engagement surface and at least one port providing a communication path to the interior of said housing.

8. The self-orientating fracing system of claim **7** wherein the centralizer imparts rotational force to the at least one ported sleeve when the centralizer moves along the surface of the open hole.

9. The self-orientating fracing system of claim **1** wherein the centralizer imparts rotational force to the at least one ported sleeve when the centralizer moves along the surface of the open hole.

10. A self-orientating fracing system for use in an open hole, the system comprising:

a swivel sub having a lower section, an upper section at least partially overlapping with the lower section, at least one bearing channel comprising a first groove in the upper section and a second groove in the lower section, a plurality of bearings in the bearing channel, and an outer housing at least partially encircling the upper section and the lower section;

at least one centralizer having an outer surface comprising a plurality of flutes; and

at least one ported sleeve between the swivel sub and the at least one centralizer, the at least one ported sleeve defining a flowpath;

wherein, the upper section and the lower section are radially rotatable relative to each other; and

the housing encircles the entire portion of the upper section which overlaps with the lower section.

11. The self-orientating fracing system of claim **10** wherein the housing is a housing assembly, the housing assembly comprising a first housing sub connected to a second housing sub, the first housing sub being attached to the upper section and the second housing sub being attached to the first housing sub, wherein at least a portion of the second housing sub encircles at least a portion of the lower section.

12. The self-orienting fracing system of claim **10** wherein the centralizer will impart rotational force to the at least ported sleeve when the centralizer is moved along a surface of the open hole.

13. The self-orientating fracing system of claim **10** wherein said at least one ported sleeve comprises a ported housing having an interior, a middle section with an asymmetrical profile, an outer surface with at least one flattened engagement surface, and at least one port providing a communication path to the interior of said housing.

14. A method for installing a ported sleeve in an open hole, the method comprising:

assembling a self-orienting ported sleeve assembly, the self-orienting ported sleeve assembly comprising:

a swivel sub having a lower section, an upper section overlapping with the lower section, at least one bearing channel comprising a first groove in the upper section and a second groove in the lower section, a plurality of bearings in the at least one bearing channel, and an outer housing at least partially encircling the upper section and the lower section;

at least one centralizer having an outer surface comprising a plurality of flutes; and

at least one ported sleeve on the same side of the swivel sub as the at least one centralizer, the at least one ported sleeve having a flowpath, therethrough;

placing the self-orienting sleeve assembly into the open hole;

moving the self-orienting sleeve assembly along the open hole with the at least one centralizer in contact with a surface of the open hole;

rotating the ported sleeve such that one or more ports in the ported sleeve are oriented in a desired direction; and
stopping rotation of the ported sleeve when the one or more ports are oriented in the desired direction.

15. The method of claim **14** wherein the ported sleeve further comprises an assymetrical section, the method further comprising the steps of bringing an exterior surface of the assymetrical section into contact with a bottom surface of the open hole.

16. The method of claim **14** further comprising contacting the housing of the swivel sub with a surface of the open hole as the self-orienting sleeve assembly is moved along the open hole.

* * * * *